Bioinformatics
CS300
Introduction

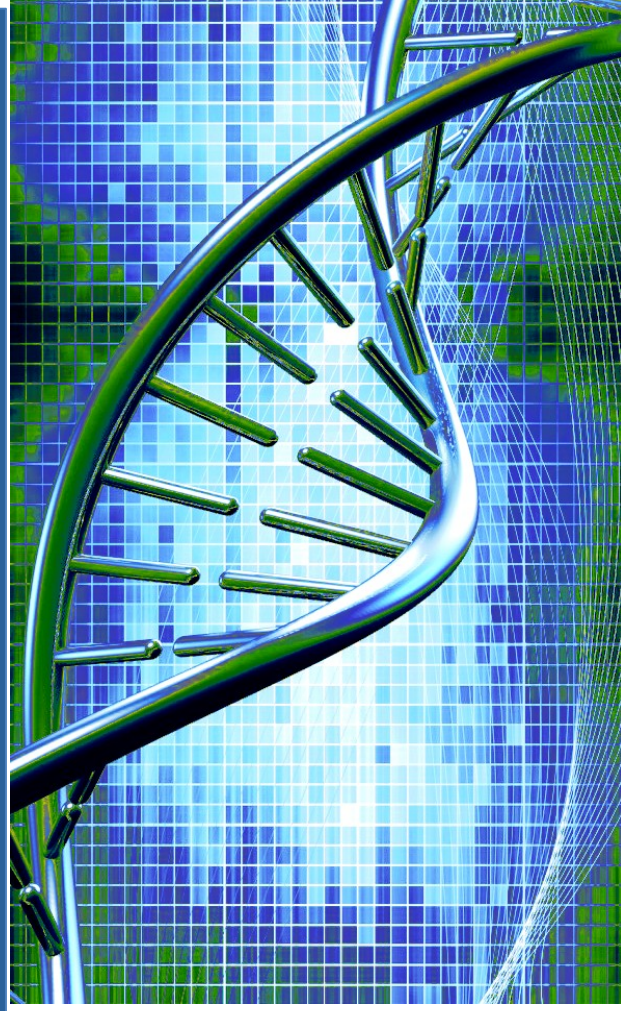
Week 1
Fall 2022
Oliver BONHAM-CARTER

Introduction to Bioinformatics

CMPSC*300

Fall 2022

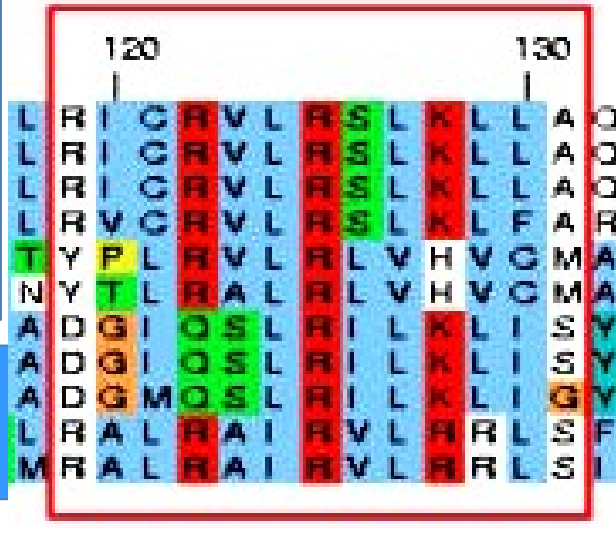
Class: M,W, F 10:00am - 10:50am
Lab: Monday 2:30-4:20pm
(Alden Hall 109)



Bioinformatics is an emerging, rapidly expanding interdisciplinary discipline that studies how to effectively integrate concepts from computational sciences and biosciences. There is a high demand for scientists who are versed in both biology and computer science in the biomedical industry and research.

CMPSC 300 students will become familiar with the state-of-the-art bioinformatics software and the algorithms behind them. Through hands-on projects, students will explore current biological problems and will develop bioinformatics solutions to these issues.

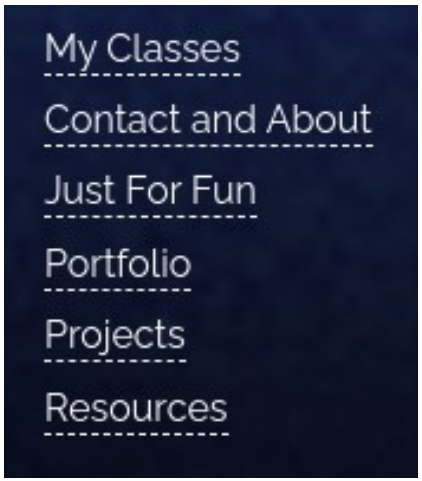
This course counts as an Applications Course for Computer Science.

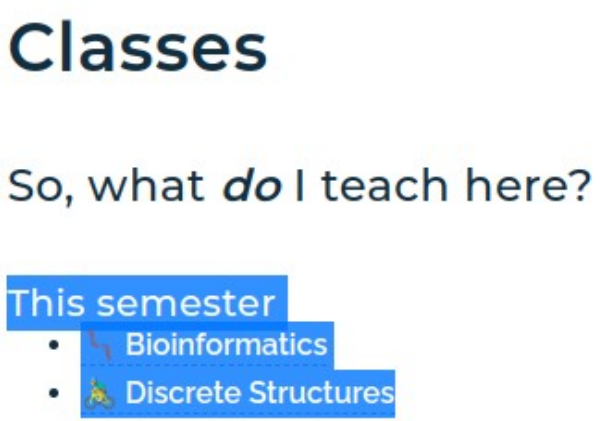


Questions? Contact Dr. BONHAM-CARTER at obonhamcarter@allegheny.edu

Class Websites

- Course Information:
  - https://www.oliverbonhamcarter.com/
- Archive and Syllabus: ***classDocs/***
  - https://github.com/CMPSC-300-Allegheny-College-Fall-2022/classDocs





How To Be Successful

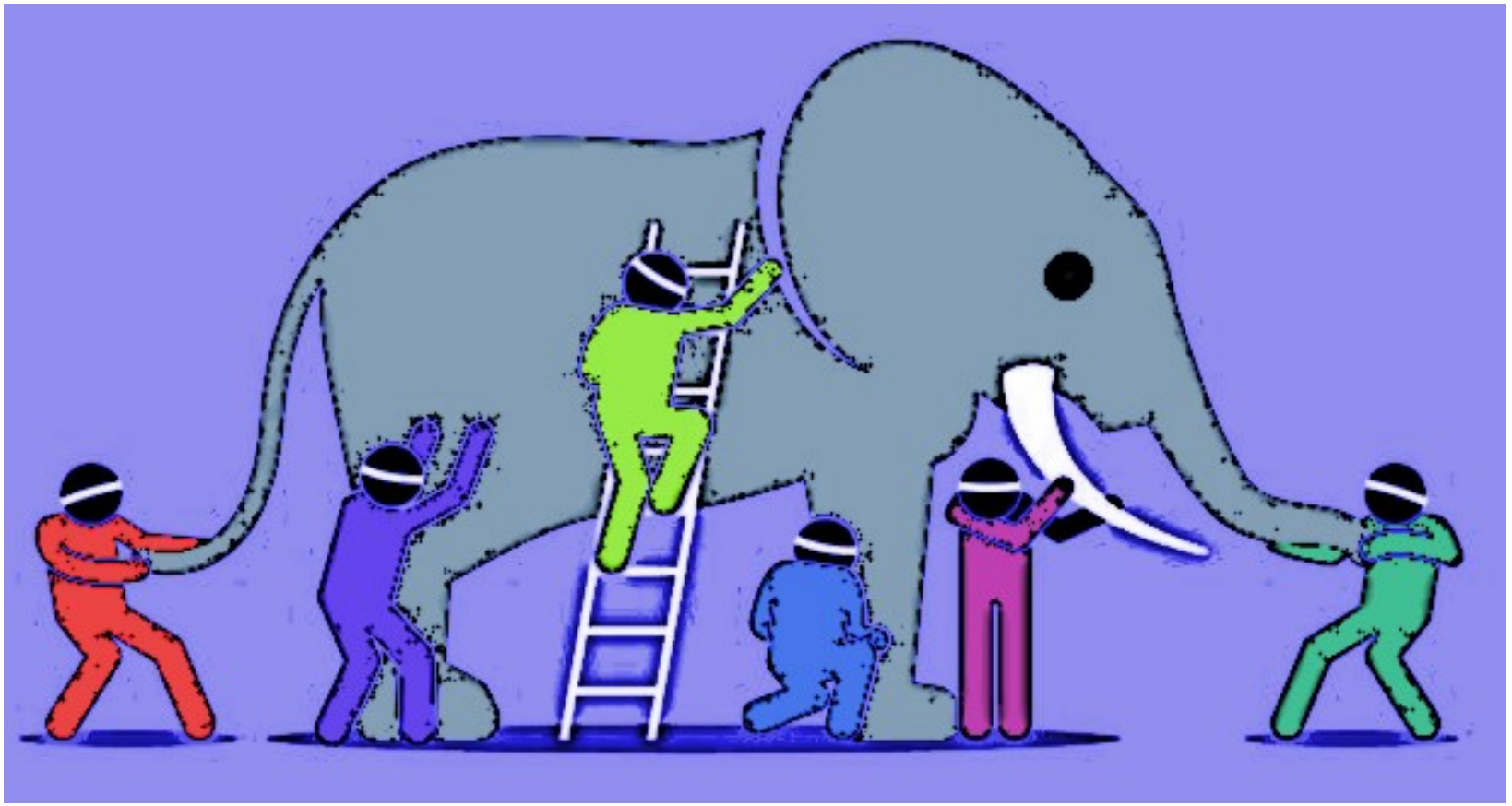
- Participate in classes and lab!!!
- Read the book and handouts!
- Keep up with your lab homework!

An Ethical Approach

- We will spend time to learn about responsibility in Bioinformatics and in its research
- Ethical considerations for research, building tools, implementing algorithms, working with life, etc ...

What is this *Bioinformatics?*

- This field has many meanings … depending on the type of research



Bioinformatics is Many Things...

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The science of collecting and analyzing complex biological data such as genetic codes.

A theoretical framework to detect genes which contribute to the onset of unhealthy development.

The field of exploration into data to describe the onset of Illness, disease and medical disorder.

Is an interdisciplinary field that develops methods and software tools for understanding biological data.

Bioinformatics is both an umbrella term for the body of biological studies that use computer programming as part of their methodology.

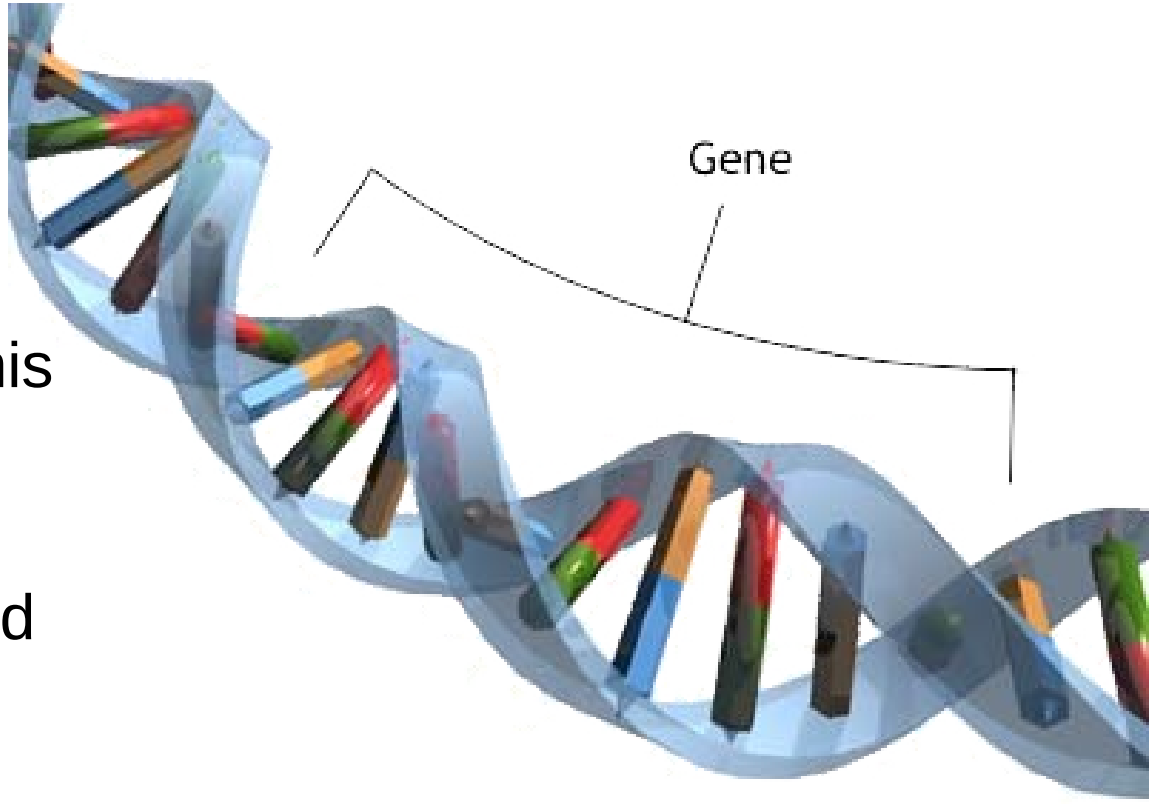
The study of data from living systems to determine patterns of life and health.

The development of tools to aid in the comparison of genetic and genomic data and more generally in the understanding of evolutionary aspects of molecular biology.

A framework used to determine the relatedness between people, dogs, cats, mice, rats, rabbits, or any living thing!

Bioinformatics:
The Study of (*all things*) DNA

- DNA is the genetic material that houses genetic information.
- Genes are written in this language.
- Understanding DNA allows us to understand how genes work.

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  1 attaaaggtt tataccttcc caggtaacaa accaaccaac tttcgatctc ttgtagatct
 61 gttctctaaa cgaactttaa aatctgtgtg gctgtcactc ggctgcatgc ttagtgcact
121 cacgcagtat aattaataac taattactgt cgttgacagg acacgagtaa ctcgtctatc
181 ttctgcaggc tgcttacggt ttcgtccgtg ttgcagccga tcatcagcac atctaggttt
241 cgtccgggtg tgaccgaaag gtaagatgga gagccttgtc cctggtttca acgagaaaac
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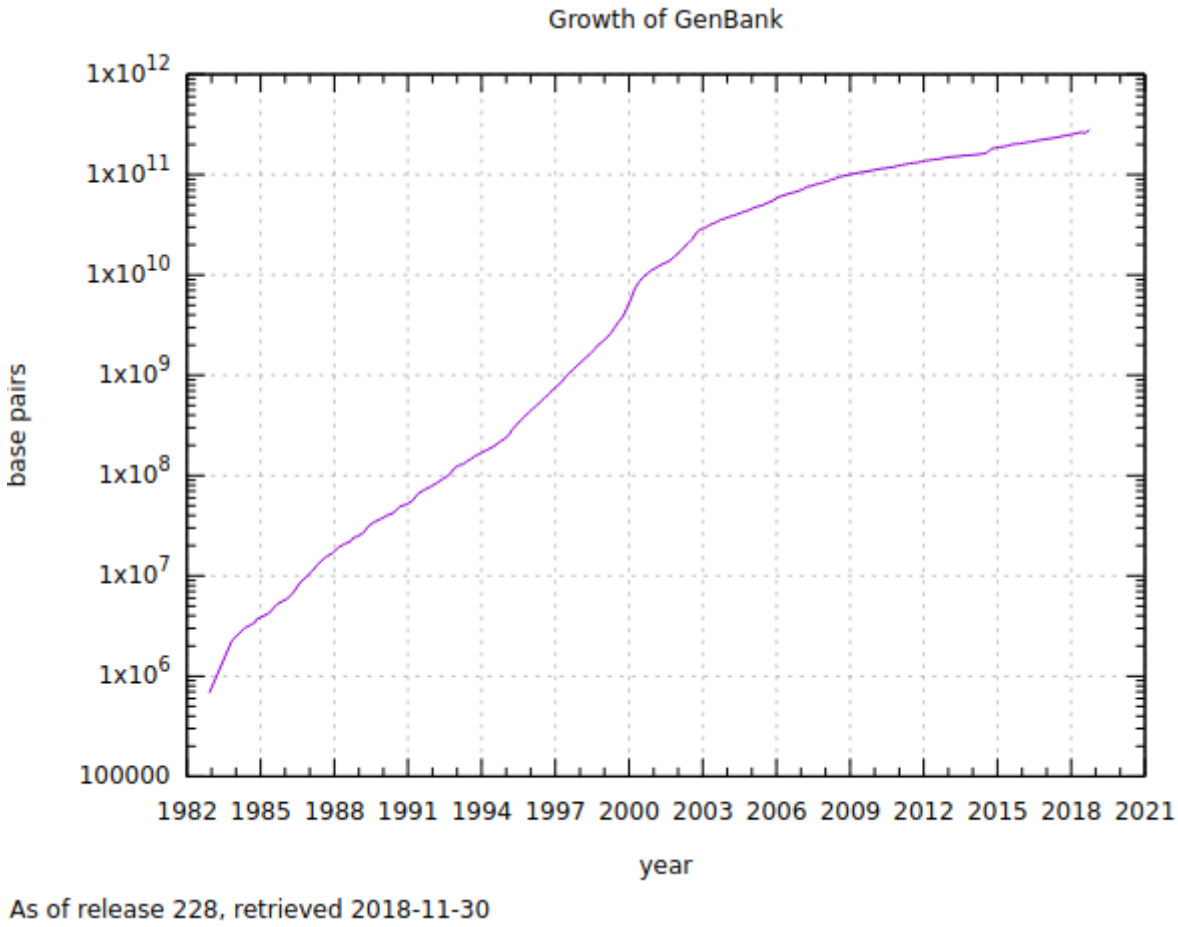
How Much DNA to Study?

- Gen Bank: Public repository of DNA sequences and related data.
- Seemingly exponential growth in amount of sequence data available for study.



An Important DNA Study That I Might Know??

- The Human Genome Project
- Large scale project to determine the genetic sequence of human DNA.
- 20th anniversary of landmark HGP publications

Another Important DNA Study ??

- Washington Post Article: Scientists extract from Siberian mammoth molars the oldest DNA ever recovered

Mammoth Molar Munchers!

Bringing them back from extinction?

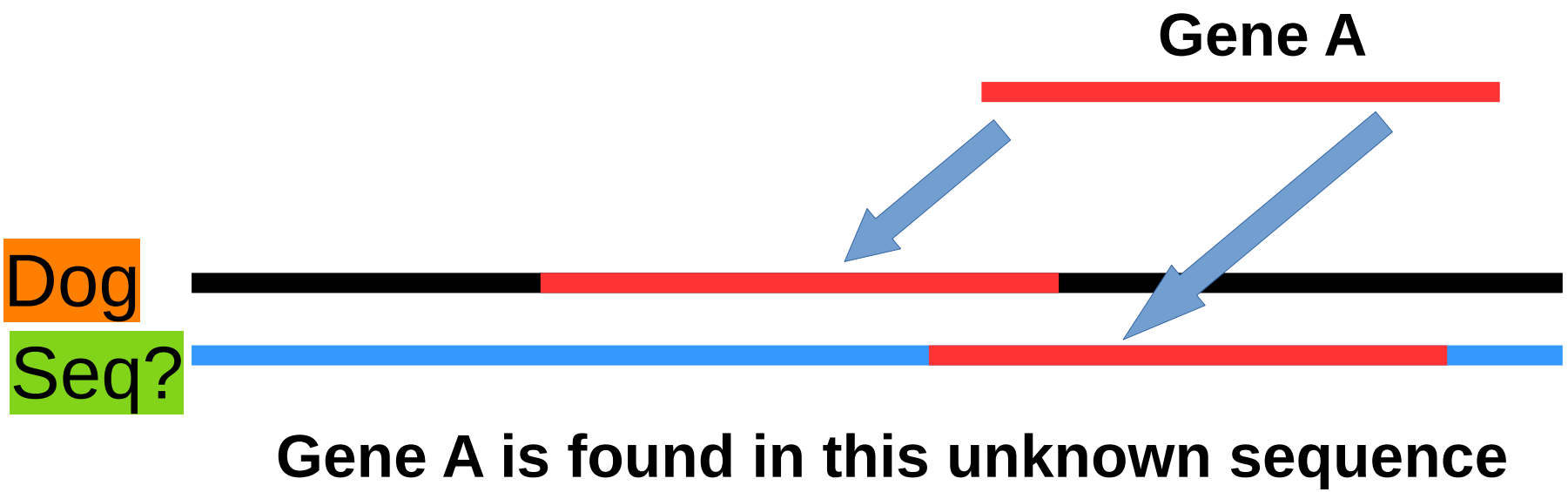
Use DNA to Compare...

- DNA sequences
- Genes
- Proteins
- Organisms

- **Why do we *compare* these things?**
- **What do we learn when *things* have similar DNA?**
  - **Or do <u>not</u> have similar genetic material?**

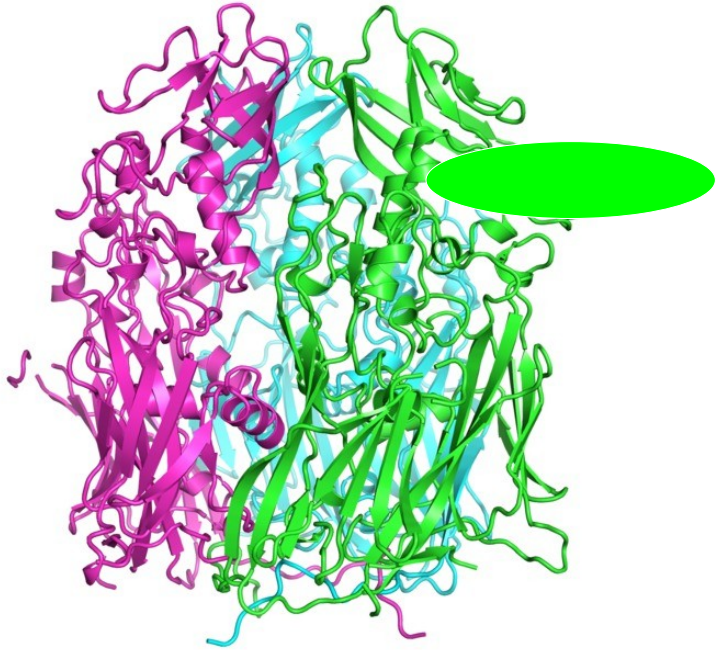
Comparing Regions?

- We scan millions of unknown DNA sequences to find familiar embedded genes.
- Does a gene have the same function each time we find it in a sequence? Same origins? Do the same disorders affect the copies of the gene?

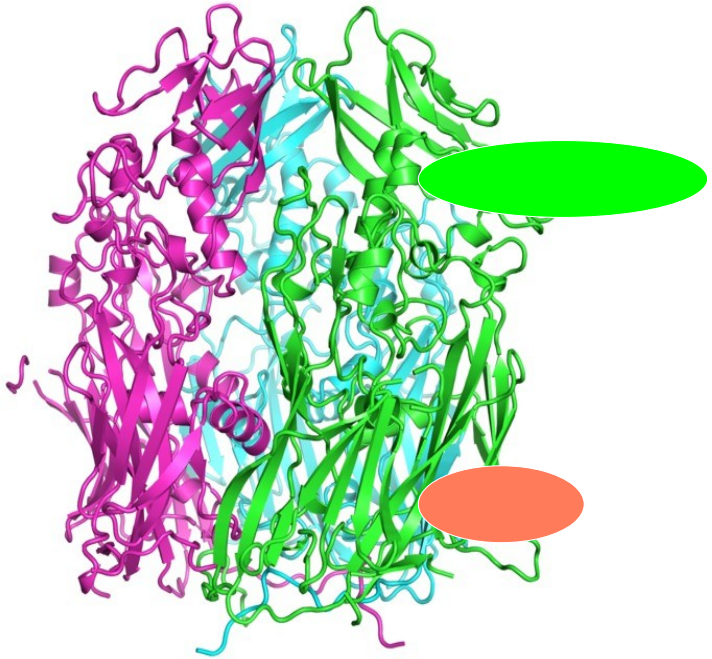


Comparing Protein

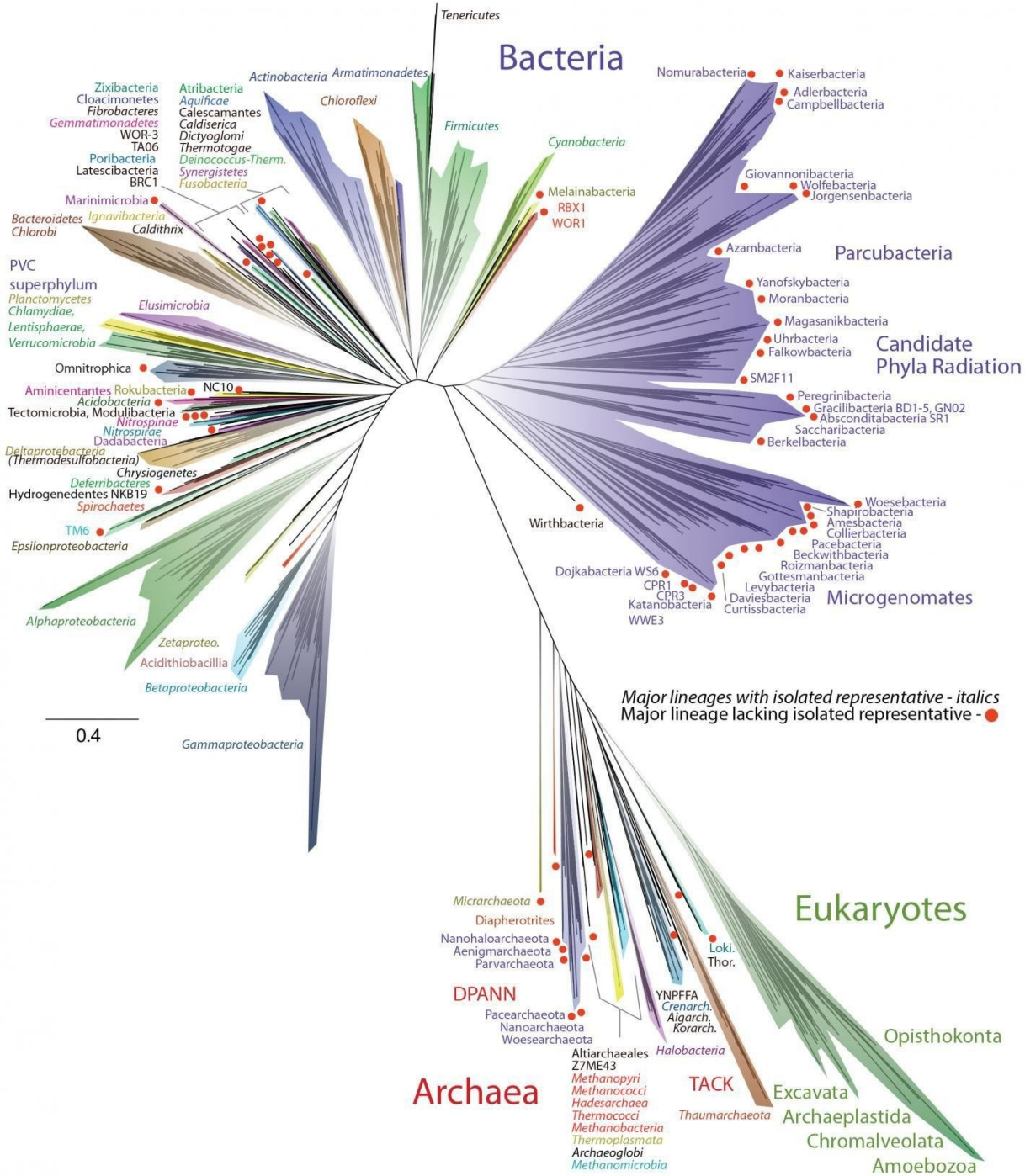
- Two proteins (wildtype, non-wildtype) are compared to find causes of disorder.



Healthy



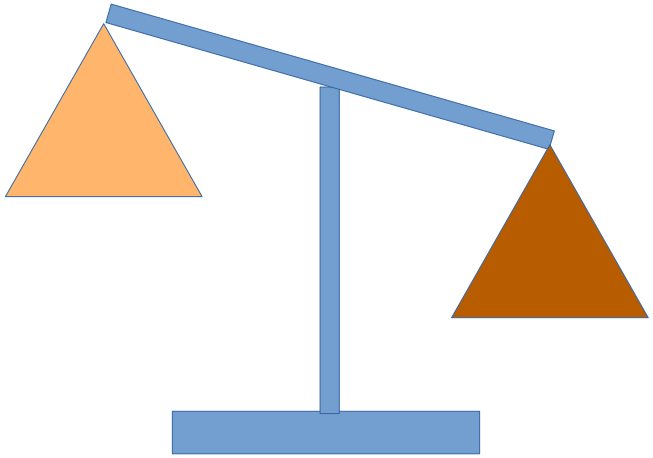
Unhealthy



Comparing organismal DNA to study the Tree of Life to Determining Relatedness

So, Why Computer Science?

- What is different between sequences?
  - Compare seq A and seq B
  - Now try seq C and seq D



Seq A: *This is a goat!*

Seq B: *This ia s boat!*

Seq C: *actcgaattt ctcgcattta cttttgtttt gaattcgcgc*

Seq D: *actcgaactt ctcgcattta ctttagttg gatttagcgc*

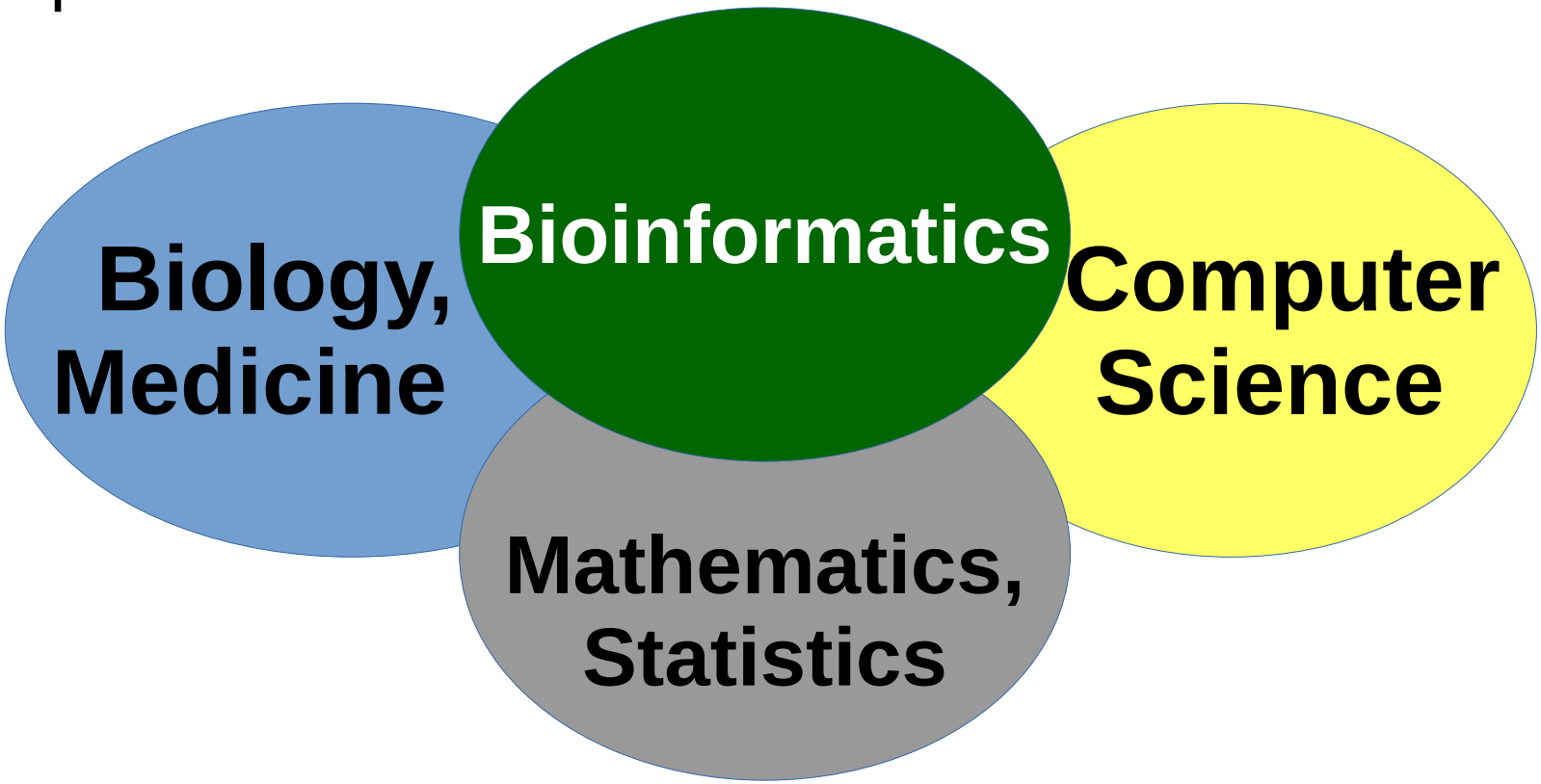
What if these sequences get *really, really* long!

General Objectives

- Sequence analysis
- Make/ use software tools to perform analyses
- Add (publicly) available bio data
- Identification of sequence similarities
- Learn the function of sequences
- Use DNA to answer questions
- And more!

As a Discipline

- Discipline: a branch of knowledge, typically one studied in higher education.
- Bioinformatics is formed out of three or four disciplines.



Consider This!

Group-work: Think about / Discuss the following:

- Think of some potential applications of bioinformatics (inferring from today's class)
- Complete the form with your group's responses (one person to submit the form from the group): https://forms.gle/14xqLpWcri7HfQcn6